

VITAE
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Education

Post-Doctoral Fellow: University of British Columbia, Vancouver, B.C.
Ph.D. 1980: Duke University, Durham, N.C.
B.Sc. (summa cum laude), 1976: Texas A&M University, College Station, TX.

Employment:

- 2008-present. Jet Propulsion Laboratory, Pasadena, CA. Senior Research Scientist, Radar Science and Engineering Section.
- 2001-2007. Jet Propulsion Laboratory, Pasadena, CA. Senior Research Scientist / Technical Group Supervisor, Polar Remote Sensing Group, Radar Science and Engineering Section.
- 1996-2000. Jet Propulsion Laboratory, Pasadena, CA. Technical Group Supervisor, Polar Remote Sensing Group, Radar Science and Engineering Section.
- 1990-1996. Jet Propulsion Laboratory, Pasadena, CA. Technical Group Supervisor, SAR Systems Development and Processing Group, Radar Science and Engineering Section.
- 1985-1989. Jet Propulsion Laboratory, Pasadena, CA. Member of Technical Staff, Radar Science and Engineering Section.
- 1981-1984. MacDonald Dettwiler and Associates, Richmond, B.C. Team Leader - Research and Development, Earth Resources Systems.
- 1980-1981. University of British Columbia, Vancouver, B.C. Post-doctoral fellow - Continuum Mechanics and Thermophysics.

Professional Affiliations/Synergistic Activities:

- Chair, RGPSC Science Working Group (1996-present).
- Associate Editor, Journal of Geophysical Research (Oceans – High latitude physics) (2003-2006)
- Associate Editor, Journal of Geophysical Research, Special section on *Small scale kinematics and dynamics of sea ice*. (2005-2006)
- Member, Science Advisory Board, International Arctic Research Center (IARC), Fairbanks, AK (2009-present)
- Member, ICESat-2 Science Definition Team (2008-present)
- Member, SEARCH Observing Change Panel (2008-present)
- Member, ICESat Science Team (2006-present)
- Member, CryoSat-2 Cal/Val Team (2006-present)
- Member, Observations Products Panel, Climate in Cryosphere (ACSYS/CLiC), World Climate Research Program (1999-2006)
- Member, Alaska SAR Facility User Working Group (1998-present)
- Member, Antarctic Mapping Advisory Group (1997-present)
- Member, WCRP Satellite Working Group (2002-2007)

Member, ALOS Science Team. (2001-present)
Member, ESTO Radar/Radiometry Working Group (2004)
Member, JPL Earth Science Advisory Group (2003-2007)
Contributing author, 2005 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report.
Member: American Geophysical Union; American Meteorological Society; Electromagnetics Academy
Fellow, Institute of Electrical and Electronics Engineers.

Honors and Awards:

NASA Exceptional Science Achievement Medal (2008)
NASA Exceptional Achievement Medal (2003)
JPL Ed Stone Award for Outstanding Research Publication (2003, 2005)
AGU 2007 Editors' Citation for Excellence in Refereeing for Geophysical Research Letters.
NASA Certificate of Achievement for New Technology:

Interferometric estimation of 3-D ice flow velocity vector from ascending and descending passes; Polarization signature of frozen and thawed forests for various biomass; Application of Neural Network for Retrieving sea ice thickness from Model-Generated Polarimetric Scattering Coefficients; Extraction of textural features in SAR imagery; Statistical model and sensitivity; Automated mosaicking system for spaceborne SAR imagery; A post processing system for automated rectification and registration of spaceborne SAR imagery; Unsupervised segmentation of Polarimetric SAR data using the Covariance Matrix; Classification of Multi-frequency multi-look SAR data.

NASA Group Achievement Award

Magellan Radar Development Team; Alaska SAR Facility Development Team.

Field Programs (Participant):

LEADEX 92 (Arctic Ocean Ice Camp) – ONR
CRRELEX 94 outdoor experiment, Hanover, New Hampshire – ONR
Great Lakes Research 95 (Lake Superior, Lake Erie)– NOAA/US Coast Guard

Books/Chapters (1 book, 9 chapters):

- Bamber, J. and R. Kwok, Measurement Techniques, in *Mass Balance of the Cryosphere: Modeling of Contemporary and Future Changes*, Eds. J. Bamber and T. Payne, Cambridge University Press, 2003.
- Kwok, R., Deformation of the Arctic Ocean sea ice cover: November 1996 through April 1997, in *Scaling Laws in Ice Mechanics and Dynamics*, edited by J. Dempsey and H. H. Shen, Kluwer Academic, 315-323, 2001.
- Rothrock, D. A., R. Kwok, and D. Groves, Satellite Views of the Arctic Ocean Freshwater Balance, in *The Freshwater Budget of the Arctic Ocean*, edited by E. Lyn Lewis, Kluwer Academic, 409-452, 2000.
- Kwok, R., S. H. Yueh, and L-L Fu, Spaceborne Radar, in *Wiley Encyclopedia of Electrical and Electronics Engineering*, Vol. 20, Ed. J. G. Webster, 15-28, 1999.
- Tsatsoulis, C. and R. Kwok, Eds. *Analysis of SAR data of the Polar Oceans: Recent Advances*, Springer Verlag, 1998.
- Kwok, R. The RADARSAT Geophysical Processor System. in *Analysis of SAR data of the Polar Oceans: Recent Advances*, Tsatsoulis, C. and R. Kwok, Eds., 235-257, Springer Verlag, 1998.
- Kwok, R., G. Cunningham and B. Holt, An Approach to Classification of Sea Ice in Spaceborne SAR Data, in *Microwave Remote Sensing of Sea Ice*, Ed. F. D. Carsey, 355-360, Geophysical Monograph 68, AGU.

- Holt, B., D. A. Rothrock and R. Kwok, Observations of Sea Ice Motion from Satellite Imagery, in *Microwave Remote Sensing of Sea Ice*, Ed. F. D. Carsey, 343-354, Geophysical Monograph 68, AGU.
- Drinkwater, M., H. Israelsson, R. Kwok, R. Onstott, E. Rignot and D. Winebrenner, Potential Applications of Radar Polarimetry to the Classification of Sea Ice, in *Microwave Remote Sensing of Sea Ice*, Ed. F. D. Carsey, 419-442, Geophysical Monograph 68, AGU.
- Kwok, R., Monitoring sea ice thickness from space. *Arctic Research of the United States*. 14, 8-14, 2000.

Refereed Journal Publications (Total: 110):

2008 – 2009 (8)

- Kwok, R., M. Wensnahan, I. Rigor, H. J. Zwally, and D. Yi (2009), Thinning and volume loss of Arctic sea ice: 2003-2008, *J. Geophys. Res.*, submitted.
- Kwok, R. (2008), Outflow of Arctic sea ice into the Greenland and Barents Seas: 1979-2007. *J. Clim.*, in press.
- Nguyen, A. T., D. Menemenlis, and R. Kwok (2008), Improved modeling of the Arctic halocline with a sub-grid scale brine rejection parameterization, *J. Geophys. Res.*, submitted.
- Lindsay, R. W., R. Kwok, L. de Steur, and W. Meier (2008), Halo of ice deformation observed over the Maud Rise seamount, *Geophys. Res. Lett.*, 35, L15501, doi:10.1029/2008GL034629.
- Kwok, R., E. C. Hunke, W. Maslowski, D. Menemenlis, and J. Zhang (2008), Variability of sea ice simulations assessed with RGPS kinematics, *J. Geophys. Res.*, 113, C11012, doi:10.1029/2008JC004783.
- Kwok, R., and G. F. Cunningham (2008), ICESat over Arctic sea ice: Estimation of snow depth and ice thickness, *J. Geophys. Res.*, 113, C08010, doi:10.1029/2008JC004753.
- Kwok, R. (2008), Summer sea ice motion from the 18 GHz channel of AMSR-E and the exchange of sea ice between the Pacific and Atlantic Sectors, *Geophys. Res. Lett.*, 35, L03504, doi:10.1029/2007GL032692.
- Zwally, H. J., D. Yi, R. Kwok, and Y. Zhao (2008), ICESat measurements of sea ice freeboard and estimates of sea ice thickness in the Weddell Sea, *J. Geophys. Res.*, 113, C02S15, doi:10.1029/2007JC004284.

2006 – 2007 (13)

- Kwok, R., G. F. Cunningham, H. J. Zwally, and D. Yi (2007), Ice, Cloud, and land Elevation Satellite (ICESat) over Arctic sea ice: Retrieval of freeboard, *J. Geophys. Res.*, 112, C12013, doi:10.1029/2006JC003978.
- Kwok, R., J. C. Comiso, S. Martin, and R. Drucker (2007), Ross Sea polynyas: Response of ice concentration retrievals to large areas of thin ice, *J. Geophys. Res.*, 112, C12012, doi:10.1029/2006JC003967.
- Kwok, R. (2007), Baffin Bay ice drift and export: 2002-2007. *Geophys. Res. Lett.*, 34, L19501, doi:10.1029/2007GL031204.
- Kwok, R. (2007), Near zero replenishment of the Arctic multiyear sea ice cover at the end of 2005 summer, *Geophys. Res. Lett.*, 34, L05501, doi:10.1029/2006GL028737.
- Morison, J., J. Wahr, R. Kwok, and C. Peralta-Ferriz (2007), Recent trends in Arctic Ocean mass distribution revealed by GRACE, *Geophys. Res. Lett.*, 34, L07602, doi:10.1029/2006GL029016.
- Kwok, R., and M. D. Coon (2006), Introduction to special section: Small-Scale Sea Ice Kinematics and Dynamics, *J. Geophys. Res.*, 111, C11S21, doi:10.1029/2006JC003877.
- Kwok, R. (2006), Exchange of sea ice between the Arctic Ocean and the Canadian Arctic Archipelago, *Geophys. Res. Lett.*, 33, L16501, doi:10.1029/2006GL027094.

- Martin, S., R. Drucker, and R. Kwok (2007) The areas and ice production of the western and central Ross Sea polynyas, 1991-2002 and their relation to the B-15 and C-19 iceberg events of 2000 and 2002, *J. Mar. Sys.*, 68, doi:10.1016/j.jmarsys.2006.11.008.
- Coon, M., R. Kwok, G. Levy, M. Pruis, H. Schreyer, and D. Sulsky (2007), Arctic Ice Dynamics Joint Experiment (AIDJEX) assumptions revisited and found inadequate, *J. Geophys. Res.*, 112, C11S90, doi:10.1029/2005JC003393.
- Schreyer, H. L., D. L. Sulsky, L. B. Munday, M. D. Coon, and R. Kwok (2006), Elastic-decohesive constitutive model for sea ice, *J. Geophys. Res.*, 111, C11S26, doi:10.1029/2005JC003334.
- Sulsky, D., H. Schreyer, K. Peterson, R. Kwok, and M. Coon (2007), Using the material-point method to model sea ice dynamics, *J. Geophys. Res.*, 112, C02S90, doi:10.1029/2005JC003329.
- Kwok, R. (2006), Contrasts in Arctic Ocean sea ice deformation and production in the seasonal and perennial ice zones, *J. Geophys. Res.*, 111, C11S22, doi:10.1029/2005JC003246, 2006.
- Kwok, R., G. F. Cunningham, H. J. Zwally, and D. Yi (2006), ICESat over Arctic sea ice: Interpretation of altimetric and reflectivity profiles, *J. Geophys. Res.*, 111, C06006, doi:10.1029/2005JC003175.

2004 – 2005 (10)

- Kwok, R. Variability of Nares Strait ice flux, *Geophys. Res. Lett.*, 32, L24502, doi:10.1029/2005GL024768, 2005.
- Kwok, R. Ross Sea ice motion, flux, and deformation, *J. Clim.*, 18(18), 3759-3776, 2005.
- Kwok, R., W. Maslowski, and S. W. Laxon (2005), On large outflows of Arctic sea ice into the Barents Sea, *Geophys. Res Lett.*, 32, L22503, doi:10.1029/2005GL024485.
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- Martin, S., R. Drucker, R. Kwok and B. Holt. Improvements in the estimates of ice thickness and production in the Chukchi Sea polynyas derived from AMSR-E, *Geophys. Res. Lett.*, 32, L05505, doi:10.1029/2004GL022013, 2005.
- McPhee, M., R. Kwok, R. Robbins, and M. Coon, Upwelling of Arctic pycnocline associated with shear motion of sea ice, *Geophys. Res. Lett.* 32, L10616, doi:10.1029/2004GL021819, 2005.
- Kwok, R., H. J. Zwally, and D. Yi, ICESat observations of Arctic sea ice: A first look, *Geophys. Res. Lett.*, 31, L16401, doi:10.1029/2004GL020309, 2004.
- Kwok, R. Annual Cycles of Multiyear Sea Ice Coverage of the Arctic Ocean: 1999-2003. *J. Geophys. Res.*, 109, C11004, doi:10.1029/2003JC002238, 2004.
- Kwok, R., G. F. Cunningham, and S. S. Pang, Fram Strait sea ice outflow, *J. Geophys. Res.*, 109, C01009, doi:10.1029/2003JC001785, 2004.
- Martin, S., R. Drucker, R. Kwok and B. Holt. Estimation of the thin ice thickness and heat flux from SSM/I data for the Chukchi Sea Alaskan coast polynya for 1990 – 2001, *J. Geophys. Res.*, 109, C10012, doi:10.1029/2004JC002428, 2004.

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- Kwok, R., G. F. Cunningham, and W. D. Hibler III, Subdaily ice motion and deformation from RADARSAT observations, *Geophys. Res. Lett.*, 30(23), 2218, doi:10.1029/2003GL018723, 2003.
- Kwok, R., G. F. Cunningham, and S. V. Nghiem, A study of melt onset in RADARSAT SAR imagery, *J. Geophys. Res.*, 108(C11), 3363, doi:10.1029/2002JC001363, 2003.
- Kwok, R., and J. C. Comiso, Spatial patterns of Antarctic surface temperature: Connections to the Southern Hemisphere Annular Mode and the Southern Oscillation, *Geophys. Res. Lett.*, 29(12), 10.1029/2002GL015415, 2002.

- Kwok, R., Sea ice concentration from passive microwave radiometry and openings from SAR ice motion, *Geophys. Res. Lett.*, 29(10), 10.1029/2002GL014787, 2002.
- Kwok, R., Arctic Ocean sea ice area and volume production: A contrast of two years – 1996/97 and 1997/98. *Ann. Glacio.* 34, 447-453, 2002.
- Kwok, R. and J. C. Comiso, Southern Ocean Climate and Sea Ice Anomalies Associated with the Southern Oscillation, *J. Clim.*, 15(5), 487-501, 2002.
- Kwok, R. and G. F. Cunningham. Seasonal ice area and volume production of the Arctic Ocean: November 1996 through April 1997, *J. Geophys. Res.*, 107(C10), 8038, 10.1029/2000JC000469, 2002.
- Wang, J., R. Kwok, J. Saucier, et al., Working toward improved small-scale sea ice-ocean modeling in the Arctic seas, *Eos, Trans. AGU*, 84(34), 325-330, 2003.
- Richter-Menge, J. A., S. L. McNutt, J. E. Overland, and R. Kwok, Relating arctic pack ice stress and deformation under winter conditions, *J. Geophys. Res.*, 107(C10), 8040, doi:10.1029/2000JC000477, 2002.
- Bardel, P., A. G. Fountain, D. Hall, and R. Kwok, Synthetic Aperture Radar Detection of the Snowline on Polar Glaciers, Taylor Valley, Antarctica, *Ann. Glacio.* 34, 177-183.
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- Nghiem, S. V., K. Steffan, R. Kwok, and W-Y. Tsai, Detection of snow melt regions on the Greenland ice sheet using diurnal backscatter change, *J. Glaciol.*, 47(159), 539-547, 2002.
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- Wang, J., R. Kwok, F. J. Saucier, J. Hutchings, M. Ikeda, W. D. Hibler III, J. Haapala, M . D. Coon, H. E. Markus Meier, H. Eicken, N. Tanaka, D. Prentki, W. Johnson, Working Toward Improved Small-scale Sea Ice Ocean Modeling in the Arctic Seas, *EOS Trans. AGU*, 84(34) 325-336, 2003.
- Wu, Xiaoping, M.M. Watkins, E.R. Ivins, R. Kwok, P. Wang, J.M. Wahr. Toward global inverse solutions for the determination of currrent and past mass variations: Contribution of secular satellite gravity and topography change measurements *J. Geophys. Res.*, 107 (B11), 2291, doi:10.1029/2001JB000543, 2002.

2000 – 2001 (7)

- Kwok, R., M. Siegert, and F. D. Carsey, Ice motion over Lake Vostok, *J. Glacio.*, 46(155), 689-694, 2001.
- Fahnstock, M.A., I. Joughin, T.A. Scambos, R. Kwok, W.B. Krabill, and S. Gogineni, Ice stream related patterns of ice flow in the interior of northeast Greenland, *J. Geophys. Res.*, 106(D24), 34035-34045, 2001.
- Fahnstock, M. A., T. A. Scambos, C. A. Shuman, R. J. Arthern, D. P. Winebrenner, and R. Kwok, Snow megadune fields on the East Antarctic Plateau: extreme atmosphere-ice interaction *Geophys. Res. Ltrs.* 27(22), 3719-3722, 2000.
- Fahnstock, M.A., I. Joughin, T.A. Scambos, R. Kwok, W.B. Krabill, and S. Gogineni, “Ice stream related patterns of ice flow in the interior of northeast Greenland,” *J. Geophys. Res.*, 106(D24), 34035-34045, 2001.
- Kwok, R., Recent changes of the Arctic Ocean sea ice motion associated with the North Atlantic Oscillation, *Geophys. Res. Lett.*, 27(6), 775-778, 2000.
- Siegert, M. J., R. Kwok, C. Mayer, and B. Hubbard, Water exchange between the subglacial Lake Vostok and the overlying ice sheet, *Nature*, 403(6770), 643-646, 2000.
- Siegert, M.J. and Kwok, R. Ice-sheet radar layering and the development of preferred crystal orientation fabrics between Lake Vostok and Ridge B, central East Antarctica. *Earth and Planetary Science Letters*. 179 (2), 227-235, 2000.

1998 – 1999 (11)

- Kwok, R., G. F. Cunningham, and S. Yueh, Area Balance of the Arctic Ocean Perennial Ice Zone: Oct 1996- April 1997, *J. Geophys. Res.*, 104(C11), 25747-25749, 1999.
- Kwok, R., G. F. Cunningham, N. LaBelle-Hamer, B. Holt, and D. A. Rothrock, Sea ice thickness from high-resolution SAR imagery, *Eos, Trans. AGU*, 80(42), 495-497, 1999.
- Kwok, R. and D. A. Rothrock, Variability of Fram Strait Flux and North Atlantic Oscillation, *J. Geophys. Res.*, 104(C3), 5177-5189, 1999.
- Kwok, R., A. Schweiger, D. A. Rothrock, S. Pang and C. Kottmeier, Sea ice motion from satellite passive microwave data assessed with ERS SAR and buoy data, *J. Geophys. Res.*, 103(C4), 8191-8214, 1998.
- Kwok, R., S. V. Nghiem, S. Martin, D. P. Winebrenner, A. J. Gow, D. K. Perovich, C. T. Swift, D. G. Barber, K. M. Golden and E. Knapp, Laboratory measurements of sea ice: Connections to microwave remote sensing, *IEEE Trans. Geosci. and Rem. Sens.*, 36(5), 1716-70, 1998.
- Kwok, R. and J. C. Comiso, The perennial ice cover of the Beaufort Sea from active and passive observations, *Annals of Glaciol.*, 25, 376-381, 1998.
- Nghiem, S.V., R. Kwok, S. H. Yueh, Diurnal Cycling effects on the microwave signatures of thin sea ice, *IEEE Trans. Geosci. Remote Sens.*, Vol. 36, No. 1, 111-124, 1998
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- Joughin, I. R., M. Fahnestock, R. Kwok, P. Gogineni, and C. Allen, Ice flow of Humboldt, Petermann and Ryder Gletscher, northern Greenland, *J. Glacio.*, 45(150), 231-241, 1999.
- Joughin, I. R., R. Kwok and M. A. Fahnestock, Interferometric estimation of three-dimensional ice-flow using ascending and descending passes, *IEEE Trans. Geosci. Remote Sens.*, Vol. 36, No. 1, 1998.
- Yueh, S. and R. Kwok, Arctic sea ice extent and melt onset from NSCAT observations, *Geophys. Res. Lett.*, 25(23), 4369-4372, 1999.

1996 – 1997 (12)

- Kwok, R., J. C. Comiso and G. F. Cunningham, Seasonal Characteristics of the Perennial sea ice cover of the Beaufort sea. *J. Geophys. Res.*, 101 (C12), 28417-28439, 1996.
- Kwok, R. and M. Fahnestock, Ice Sheet Motion and Topography from Radar Interferometry, *IEEE Trans. Geosci. Remote Sens.* Vol. 34, No. 1, 189-200, 1996.
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- Joughin, I. R., M. Fahnestock, S. Ekholm and R. Kwok, Balance velocities of the Greenland ice sheet, *Geophys. Rev. Lett.*, 24(23), pp. 3045-3048, 1997.
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- Liu, A. K., S. Martin and R. Kwok, Tracking of ice edges and ice floes by Wavelet analysis of SAR Images, *J. Atmos. Oceanic Tech.*, 14, 1187-1198, 1997.
- Nghiem, S., R. Kwok, S. Yueh, A. J. Gow, D. K. Perovich, J. A. Kong and C. C. Hsu, Evolution in polarimetric signature of thin saline ice under constant growth, *Radio Science*, Vol. 32, No. 1, pp. 127-151, 1997.

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1994 - 1995 (15)

- Kwok, R., D. A. Rothrock, H. L. Stern and G. F. Cunningham, Determination of Ice Age using Lagrangian Observations of Ice Motion, *IEEE Trans. Geosci. Remote Sens.*, Vol. 33, No. 2, pp. 392-400, 1995.
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- Yueh, S. H., S. V. Nghiem, R. Kwok, W. J. Wilson, F. K. Li, J. T. Wilson and J. A. Kong, Polarimetric thermal emission from periodic water surfaces, *Radio Science*, Vol 29, No. 1, 87-96, 1994.
- Kwok, R., E. Rignot, J. Way, A. Freeman and J. Holt., Polarization Signatures of Frozen and Thawed Forests of Varying Environment State, *IEEE Trans. Geosci. Remote Sens.*, Vol. 32, No. 2, pp. 371-381, 1994.
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1992 – 1993 (7)

- Fahnstock, M., R. Bindschadler, R. Kwok, and K. Jezek, Greenland Ice Sheet Surface Properties and Ice Dynamics from ERS-1 Synthetic Aperture Radar Imagery, *Science*, Vol. 262, 1530-1534, 1993.

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